Appendix A

1. Title and Approval Page:

Brownfields Quality Assurance Project Plan (QAPjP) for the Former Eastern Auto Body, 29 Winfield Street Property

Document Title:

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16/8/2002
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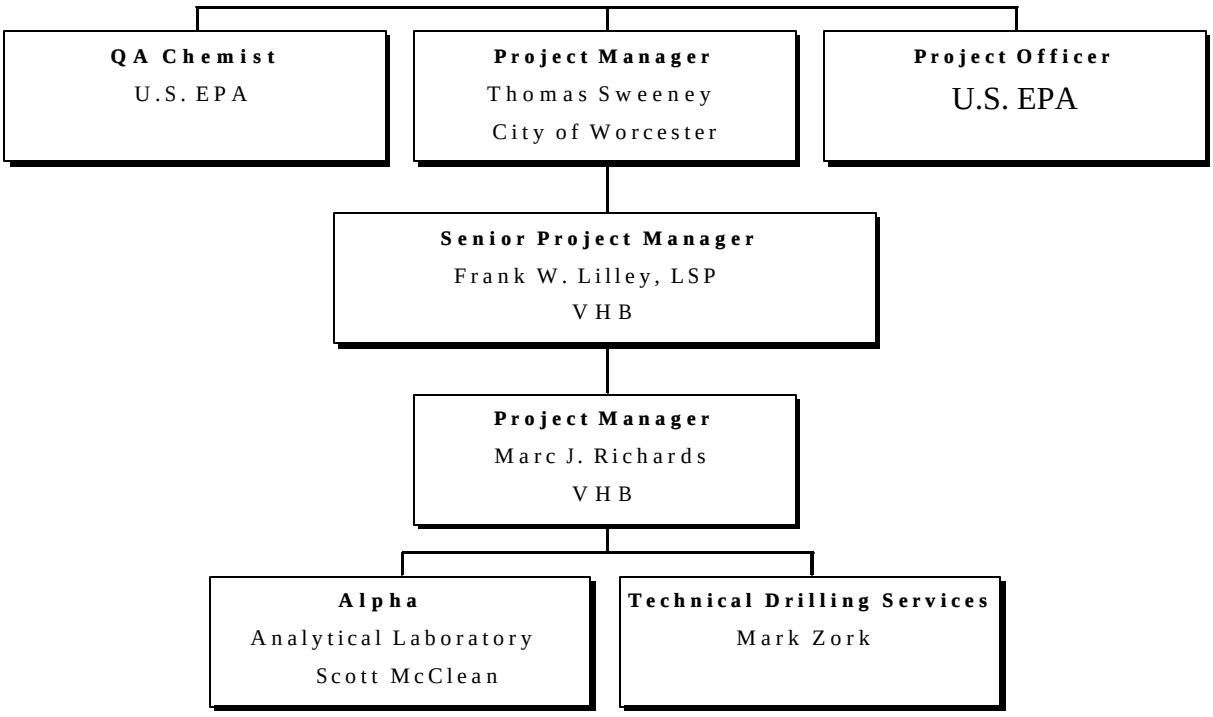
Appendix B

2. Project Organization and Responsibility:

Vanasse Hanger Brustlin, Inc. (VHB) was retained by the City of Worcester Executive Office of Economic Development (EOED) to provide environmental consulting and Licensed Site Professional (LSP) services at the 29 Winfield Street property. As shown on Figure 1, Site Location Map, the property is located at 29 Winfield Street in the City of Worcester, Massachusetts. This Quality Assurance Project Plan (QAPjP) is subject to the terms and conditions of the Agreement between EOED and VHB. The QAPjP has been prepared in accordance to the Environmental Protection Agency (EPA) guidance document, "Quality Assurance Guidance for Conducting Brownfields Site Assessments", dated September 1998.

The following organizational chart identifies the chain of command of key personnel for the project.



Appendix C

3. Problem Definition:

The 0.54-acre former EASTERN Auto Body property (Site) is located at 29 Winfield Street in Worcester, Massachusetts. The City of Worcester acquired the Site through tax foreclosure. Areas surrounding the Site include Winfield Street to the north, Mason Street to the east, an abandoned laundry facility to the south/southeast and mixed commercial and residential property to the northeast and southwest.

The City of Worcester intends to demolish the existing former automotive service facility to clear the Site for future redevelopment.

Prior to the City of Worcester's acquisition of the property, the Site operated as an auto body repair shop and, most recently, a paving company. Before being developed for commercial purposes in the 1970s, the Site was occupied by residential buildings. The existing building at the Site was constructed in the 1920s. The Site is currently abandoned and vacant.

Prior to building demolition, VHB will perform a Comprehensive Site Assessment to investigate "suspect" areas of the property identified during the Phase I Environmental Site Assessment prepared by VHB in August 2002. VHB identified the following 14 areas of environmental concern (AOC) which are summarized in the following table:

Table 1: Areas of Environmental Concern

AOC ID	AOC Description	Location	Rationale
1	Floor drains 1 and 2	Adjacent to service bays #2 and #3	Contains oily debris and sediment.
2	Suspect oil/water separator	Service bay #4	Contains oil, water and sludge.
3	Former below grade oil change structure	Service bay #2	Used to change oil and service vehicles.
4	Floor drains 3 and 4	Adjacent to service bay #1	Contains oily debris and sediment
5	Suspect dry well 1	Adjacent to former hydraulic lifts	Contains oily debris and sediment.
6	Former hydraulic lifts 1 and 2	Adjacent to offices and paint booth	Below grade lift cylinders contained hydraulic oil.
7	Suspect dry well 2	Outside of paint booth	Contains oily debris and sediment
8	Suspect dry well 3	Inside paint booth	Contains oily debris and sediment.
9	Suspect dry well 4	Adjacent to waste oil storage area and boiler room	Contains separate phase oil, water, oily debris and sediment.
10	Suspect petroleum UST vent pipe	Exterior of service bay #4 on property Line.	Strong fuel oil odors from pipe.
11	Former electrical transformer area	Exterior, southwest corner of building.	Former electrical transformer area. Suspect PCBs in soil.
12	Suspect UST(s)	Adjacent to Winfield Street access gate.	Metal detector survey identified suspect metal anomalies. Adjacent to concrete apron of unknown use.
13	Migrating groundwater plume	Mason Street	Upgradient edge of groundwater contamination on IL property not defined.
14	Former residential houses	Near Mason Street gate access.	Potential for buried demolition debris.

In general, the Phase I Initial Site Investigation consisted of a site reconnaissance, environmental database search, and records review. Environmental sampling and analysis was not included as part of the Phase I investigation. Contaminants of concern (COC) have been identified based on observations made during the field reconnaissance, interviews with people knowledgeable of the historic site operations, and basic site knowledge of COCs that may be present. Based on the COCs, the

Massachusetts Contingency Plan (MCP) Reportable Concentration (RC) action levels for the Site are expected to be soil category RCS-1 and groundwater category RCGW-2. Action levels for common COCs expected at the Site include the following:

	Soil (mg/kg)	Groundwater (mg/l)
Polychlorinated Biphenyls (PCBs)	2	0.0003
Extractable Petroleum Hydrocarbons (EPH)		
C_9-C_{18} Aliphatics	1,000	1
C_{19}-C_{36} Aliphatics	2,500	20
C_{11}-C_{22} Aromatics	200	30
Volatile Petroleum Hydrocarbons (VPH)		
C_5-C_9 Aliphatics	100	1
C_9-C_{12} Aliphatics	1,000	1
C_9-C_{10} Aromatics	100	4
Polycyclic Aromatic Hydrocarbons (PAHs)		
Benzo(a)Anthracene	0.7	0.005
Benzo(b)Fluoranthene	0.7	0.007
Benzo (a)Pyrene	0.7	0.002
Metals		
Lead	300	5.0
Chromium	1,000	2
Copper	1,000	100
Cadmium	30	0.01
Nickel	300	0.08
Arsenic	30	0.4
Volatile Organic Compounds (VOCs)		
Benzene	10	2
Ethylebenzene	80	4
Toluene	90	6
Xylene	500	6
Perchloroethylene (PCE)	0.5	3
Trichloroethylene (TCE)	0.4	0.3
Vinyl Chloride	0.3	0.002

The laboratory method detection limits for the above listed COCs, as well as other contaminants not

listed, are well below the RCS-1 and RCGW-2 reporting guidelines established by the MCP. This ensures that no detection limit is greater than a listed RC. The volatile organics compounds, semi-volatile organics compounds, and volatile petroleum hydrocarbons will be adequately detected by a field photo ionization detector (PID). The PID is equipped with a 10.0 ev lamp. This lamp is capable of detecting a wide variety of ionizable volatile and semivolatile organic compounds with a detection limit of 0.1 ppm and a operating range of zero to 2,000 ppm. The ionization potential of the lamp is sufficiently greater than the ionization potential of many contaminants of concern at the Site, which enables the PID to detect the wide range of contaminants. The PID measure total ionizable volatile organic compounds (TVOCs) and is not compound specific; therefore, the PID will aid in the collection of the appropriate soil sample for the appropriate analysis. Site action levels will be based on reported laboratory analytical results and not the results of the PID.

Appendix D

4. Project Description:

The proposed investigation consists of a Comprehensive Site Assessment to determine the presence or absence of oil and / or hazardous materials in "suspect" areas identified in the Phase I report. Eleven soil borings (B-1 through B-11) will be advanced by a track-mounted GeoProbe®, enabling continuous sampling from ground surface to the groundwater interface (approximately 10 feet below grade). Soil samples will be collected by the GeoProbe® using a one and two-inch diameter stainless steel core barrels equipped with dedicated acetate sleeve liners. In addition, three test pits (TP-1 through TP-3) will be excavated with a backhoe to investigate suspected underground storage tank (UST) locations.

Soil samples will be collected and field screened using a standard methodology for the jar headspace analytical screening procedure. The headspace procedure uses a PID calibrated to a 100 part per million (ppm) isobutylene standard. Field screening samples will be collected from depth intervals that indicate marked changes in soil strata, overt or olfactory evidence of oil or hazardous material contamination, or proximity to the apparent water table.

Five small-diameter groundwater monitoring wells will be installed with the GeoProbe®. Monitoring wells are anticipated be installed in soil boring locations B-1, B-2, B-4, B-6, and B-9. Each well will be constructed of one-inch diameter PVC well materials with ten feet of screen. A sand pack will be placed from the soil boring terminus to one foot above the screen followed by a clay bentonite seal. Each well will be capped with a flush-mounted road box. All monitoring wells will be developed the day of installation to remove accumulated sediment.

Prior to groundwater sampling, each well will be purged and sampled. Groundwater samples will be collected using a peristaltic pump equipped with dedicated teflon tubing for each of the site monitoring wells. Groundwater sample collection will be performed in accordance with the USEPA Region I Low Stress (low flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells, dated July 30, 1996. All groundwater samples will be preserved on ice and delivered to

a Alpha Analytical Laboratory for chemical analyses.

The following project timetable provides a schedule of site investigation activities.

Appendix D (Cont.)

4a. Project Timeline:

Activities	Project Start Dates (MM/DD/YY) Project End
Submit Draft QAPjP	8/26/02
City Review	8/26/02 – 8/27/02
EPA Review	8/28/02 – 9/13/02
Subsurface Investigation	9/18/02 – 9/20/02
Groundwater Sampling	9/23/02
Receipt of all Laboratory Analyses	9/30/02
Data Review/Validation	10/04/02
Prepare Investigation Report	9/23/02 - 10/09/02
City Review of Investigation Report	10/11/02
Submit Final Report	10/18/02

Appendix E

5. Sampling Design:

Phase II Comprehensive Site Assessment activities will investigate "suspect" OHM releases that may have impacted the Site, as previously describe in Appendix C. Based on information collected to date, there are no confirmed release areas at the Site. Sample locations and rationale are shown in Table 2 and on Figure 2.

The preliminary investigation program summarized in Table 2 represents areas of the Site to be investigated and the rationale of each location. The project budget includes a laboratory allowance to documented in the field notes and the final report. The soil samples submitted for laboratory analyses will be collected from depth intervals that indicate elevated headspace readings (greatest headspace result or greater than background), marked changes in soil strata, overt or olfactory evidence of oil or hazardous material contamination, or proximity to the apparent water table.

Sample locations and numbers of laboratory samples may change. As proposed changes are identified, field personnel will communicate to VHB's project manager, followed by VHB communication to the City of Worcester for concurrence and approval. Any changes in the sampling design will be appropriately documented in the final subsurface investigation report.

Table 2: Preliminary Environmental Media Assessment and Analysis Plan

Sample ID	Location	Rationale	Anticipated Soil Analyses*	Anticipated Groundwater Analyses*
TP-1	East Parking Area	Former location of residential houses. Potential for buried solid waste debris.	Field observation only.	NA
TP-2	Southeast Parking Area	Suspected fuel oil UST location.	EPH and/or VPH	NA
TP-3	North Parking Area. Winfield Street Gate Access.	Suspected UST location.	EPH and/or VPH	NA
B-1/MW-1	Mason Street Gate Access	Potential groundwater plume migrating from upgradient source.	VOCs	VOCs
B-2/MW-2	Southeast Parking Area	Suspected UST location.	EPH and/or VPH	EPH and/or VPH, VOCs
B-3	Bay #4	Suspected oil-water separator /dry well location.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs	NA
B-4/MW-3	Bay #2	Suspected oil change pit and floor drains.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs	EPH, RCRA 8 Metals, Copper, Nickel, VOCs
B-5	Bay #1	Floor drains.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs	NA
B-6/MW-4	Waste oil storage area	Suspected dry well/pit.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs, PCBs	EPH, RCRA 8 Metals, Copper, Nickel, VOCs
B-7	Central Portion of Building Interior	Suspected dry well/pit.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs	NA
B-8	Western Portion of Building Interior	Former hydraulic lift and suspect dry well/pit location.	EPH, RCRA 8 Metals, Copper, Nickel, VOCs, PCBs	NA
B-9/MW-5	Spray Paint Booth	Suspected dry well/pit.	RCRA 8 Metals, Copper, Nickel, VOCs	RCRA 8 Metals, Copper, Nickel, VOCs,
B-10	Exterior of southwest building corner	Former electrical transformer area.	PCBs	NA
B-11	West Parking Area	Site coverage.	Based on actual site conditions encountered.	NA

* - Analyses will vary based actual field conditions encountered.

Appendix F

6. Sampling and Analytical Methods Requirements:

Soil observations will be made through the advancement of up to 11 soil borings using GeoProbe equipment and three excavated test pits. Groundwater observations will be made through the installation of five Geoprobe monitoring wells, as previously described in Appendix D. Wells are proposed to be installed in soil boring locations B-1, B-2, B-4, B-6 and B-9.

As appropriate, selected soil samples will be collected and field screened for total ionizable volatile organic compounds (TVOCs) using a photoionization detector (PID) according to the Massachusetts Department of Environmental Protection (DEP) Policy #WSC-94-400, "Interim Remediation Waste Management Policy for Petroleum Contaminated Soil". Field procedures field screening of soil samples, soil and groundwater collection, and equipment decontamination are included in Appendix S.

The following sample holding times shall be used as a guidance for specific analytical methods, as shown in Table 3. Container information is also provided but may vary between certified laboratories. Each laboratory will be contacted for specific requirements for sample containers and volume due to differing laboratory quality control programs.

Table 3: Sampling and Analytical Methods and Requirements

Parameter	Matrix	Analytical Method	Sampling SOP	Container, Number, and Size	Preservation	Maximum Holding Time
VOCs	Soil	1a	1c, 3c, 4c	1 - 40 mL amber glass VOA vial	Cool 4°C, preserved with methanol	14 days
	Water	1a	2c, 5c	2 - 40 ml amber glass VOA vials	Cool 4°C, preserved with HCl	14 days
RCRA 8 Metals	Soil	2a	1c, 4c	1 – 8 oz glass jar	NA	180 days
	Water	2a	2c	1 - 0.5 liter plastic jar	NA preserved with HNO_3	180 days
EPH	Soil	3a	1c, 3c, 4c	1 – 4 oz amber glass jar	Cool 4°C	7 days
	Water	3a	2c, 5c	2 - 1 liter amber glass jars	Cool 4°C, preserved with HCl	14 days
VPH	Soil	5a	1c, 3c, 4c	2 - 40 ml amber VOA vials	Cool 4°C Preserved with Methanol	28 days
	Water	5a	2c, 5c	2 - 40 ml amber VOA vials	Cool 4°C Preserved with HCl	14 days
PCBs	Soil	4a	1c, 4c	1 – 8 oz. glass jar	Cool 4°C	14 days
	Water	4a	2c	2 - 1 liter amber glass jars	Cool 4°C	7 days

Appendix F (continued)

Method and SOP Reference Tables:

Analytical Method Reference:	Project Analytical SOPs**:
1a. SW-846, Method 8260B, 6/3/97	1b. SOP/03-03, VOCs by GC/MS, 4/11/2000, Alpha Analytical, Inc.
2a. SW-846, Method 6010B, 6/3/97	2b. SOP/06-01, ICP - AES, 6/11/2000, Alpha Analytical, Inc.
3a. Massachusetts DEP, EPH, 1/98	3b. SOP/04-07, EPH, 5/2/2000, Alpha Analytical, Inc.
4a. SW-846, Method 8081,8082, 6/3/97	4b. SOP/04-05, Organochlorine Pesticides and PCBs by CCGC, 7/17/2000, Alpha Analytical, Inc.
5a. Massachusetts DEP, VPH, 1/98	5b. SOP/04-08, VPH, 5/3/2000, Alpha Analytical, Inc.
6a. SW-846, Method 7470, 6/3/97	6b. SOP/06-02, Mercury in Liquid Waste, Automated Cold-Vapor Technique, 2/28/2001, Alpha Analytical, Inc.

Project Sampling SOPs*:
1c. Field SOP-1, 7/97, VHB, Inc.
2c. Field SOP-2, 7/97, VHB, Inc.
3c. Field SOP-3, 7/97, VHB, Inc.
4c. Field SOP-4, 7/97, VHB, Inc.
5c. Field SOP-5, 7/97, VHB, Inc.

* See Appendix S for Project Sampling SOPs
** See Appendix T for Laboratory SOPs

Appendix G

6. Preventative Maintenance - Field Equipment:

Field equipment to be used during the project includes the use of a PID to screen soil samples. Table 4 summarizes preventative maintenance during PID usage:

Table 4: Field Equipment Preventative Maintenance

Instrument	Activity	Frequency	SOP Reference
PID	Check Charge/Battery	Before each use.	3c
YSI Flow Through Cell (Low Flow Sampling)	Check Charge/Battery	Before each use.	Not applicable. Equipment is rented from outside vendor who is responsible for all preventative maintenance.

Appendix H

6. Calibration and Corrective Action - Field Equipment:

Field equipment to be used during the project includes the use of a PID to screen soil samples. Table 5 summarizes calibration and corrective action procedures during PID usage:

Table 5: Field Equipment Calibration and Corrective Action Procedures

Instrument	Activity	Frequency	Acceptance Criteria	Corrective Action	SOP Ref.
PID	Calibration Check	Once per day or every 10 samples, whichever is more frequent.	± 25% of expected value of calibration gas	Recalibrate. If still out of range, consider not using field results.	3c
YSI Flow Through Cell (Low Flow Sampling)	Calibration Check (pH, ORP, DO, Conductivity)	Once every two days.	As per manufacturer's guidelines. Vendor performs all initial calibration prior to rental.	Recalibrate per manufacturer's instructions. If still out of range, remove and recondition probe. If still out of range, notify rental vendor and request new equipment.	Not applicable. Equipment is rented from outside vendor. All calibrations performed in accordance with manufacturer's instructions.

Appendix I

6. Preventive Maintenance - Laboratory Equipment:

All laboratory equipment used for sample analyses is routinely calibrated and preventative maintenance is routinely performed. The proper maintenance and calibration of laboratory instrumentation is a key element in the quality of the chemical analysis performed by the laboratory. Each type of instrumentation and each EPA-approved analytical method have specific requirements for the calibration procedures, depending on the analyte of interest and the environmental medium being tested. The calibration protocols meet or exceed the minimum method criteria requirements. Tables 6 and 7 summarize the laboratory's preventative maintenance, calibration, and corrective action procedures:

Table 6: Laboratory Equipment Preventative Maintenance

Instrument	Activity	Frequency	EPA Method
GC/MS - Purge and Trap	Replace septa	As needed	1b, 5b
	System bake	Daily	
	Check gas	Daily	
	Clean/replace liner	As needed	
	Change column	As needed	
	Change ferrules	As needed	
	Replace traps	As needed	
	Check vacuum pump oil	Twice per year	
GCMS Semi-VOA	Check gas	Daily	3b
	System bake	Daily	
	Replace septa	Daily	
	Replace glass wool	Daily	
	Clean/replace liner	As needed	
	Replace column	As needed	
	Change ferrules	As needed	
	Check vacuum pump oil	Twice per year	

GC/MS - Gas Chromatography/Mass Spectrometer

GC- Gas Chromatography

Table 6: Laboratory Equipment Preventative Maintenance (continued)

Instrument	Activity	Frequency	EPA Method
GC	Check gas	Daily	4b
	Replace septa	Daily	
	Replace glass wool	Daily/as needed	
	Clean/replace liner	As needed	
	Replace column	As needed	
	Change ferrules	As needed	
ICP	Check/Change Pump Tubing	Daily	2b
		As needed	
	Change Capillary Tubing	Monthly/As needed	
	Clean Nebulizer	Monthly/As needed	
	Clean Spray Change	As needed	
	Clean Torch	As needed	
Atomic Absorption Mercury Cold Vapor	Clean Aerator	As needed	6b
	Clean Cell	Monthly	
	Clean Windows	Monthly	
	Change Tubing	As needed	

GC/MS - Gas Chromatography/Mass Spectrometer

GC- Gas Chromatography

ICP- Inductively Coupled Plasma

Appendix J

6. Calibration and Corrective Action - Laboratory Equipment:

Table 7: Laboratory Equipment Calibration and Corrective Action

Instrument	Activity	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
GC/MS	BFB Tuning	Every 12 hours.	±15% Difference Required Intensities: 50m/z – 15% to 40% of m/z 95 75m/z – 30% to 60% of m/z 95 95m/z – 100% of relative abundance 96m/z – 5% to 9% of m/z 95 173m/z – less than 2% of m/z 174 174m/z – greater than 50% of mz/95 175m/z – 5% to 9% of m/z 174 176m/z – 95% to 101% of m/z 174 177m/z – 5% to 9% of m/z 176	Retune until criteria met.	1a, 1b, 5a, 5b
	Initial Cal. (5 stds)	As Needed.	<15% RSD minimum response factors must be: chloromethane 0.10; 1,1-dichloroethane 0.10; bromoform 0.10; chlorobenzene 0.30; 1,1,2,2-tetrachloroethane 0.30	Recalibrate.	
	Method Blank	1 per batch	< reporting limit for target compounds	Determine cause, correct problem and return.	
	Cont. Calibration (mid point)	Every 12 hours.	±20% of expected	Reanalyze. If still out, then run is stopped and the problem corrected.	
	Surrogate Stds.	All standards, blanks, and samples.	75-125% (4-BFB) 75-125% (1,2-DCA-d4) 75-125% (Toluene-d8) 75-125% (DBFB)	Repeat analysis. If still out then qualify due to matrix interference.	

Table 7: Laboratory Equipment Calibration and Corrective Action (continued)

Instrument	Activity	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
GC	Initial Cal. (5 stds)	As Needed.	<25% RSD	Recalibrate.	3a, 3b, 4a, 4b
	Method Blank	1 per 20 samples or per batch, which ever is more frequent.	<DL	Determine cause, correct problem and return.	
	Cont. Calibration (mid point)	Every 20 samples.	±25% of expected	Reanalyze. If still out, then run is stopped and the problem corrected.	
	Surrogate Stds.	All standards, blanks, and samples.	40-140% recovery	Repeat fractionation and analysis. If still out, then qualify due to matrix interference.	
Atomic Absorption Mercury Cold Vapor	Initial Calibration	Beginning and end of each run.	Within 5% of expected value.	Terminate analysis, correct problem and recalibrate. Reanalyze.	6a, 6b
	Cont. Calibration	Every 10 samples.	Within 5% of expected value.	Terminate analysis, correct problem and recalibrate. Reanalyze.	
	Calibration Blanks	1 per batch.	< detection limit.	Reanalyze.	
	Laboratory Control Sample	1 per batch.	Within 30% of actual value.	Reanalyze.	
	Matrix Spike	1 per batch.	70 – 130% Recovery	Either re-prep and reanalyze or perform post analytical spike.	

Table 7: Laboratory Equipment Calibration and Corrective Action (continued)

Instrument	Activity	Frequency	Acceptance Criteria	Corrective Action	SOP Reference
ICP	Initial Calibration	Beginning and end of each run	within 5% of expected value	Terminate analysis, correct problem and recalibrate. Reanalyze.	2a, 2b
	Cont. Calibration	Following daily calibration, after every 10 samples, and at end of run.	within 10% of expected value	Terminate analysis, correct problem and recalibrate. Reanalyze.	
	Interference Check Sample	At beginning of each run	within 20% of true value	Reanalyze	
	Calibration Blanks	1 per batch	< detection limit	Reanalyze	
	Laboratory Control Sample	1 per batch	within 25% of actual value	Reanalyze	
	Matrix Spike	1 per batch	75-125% recovery	Either re-prep and reanalyze or perform post analytical spike	

GC/MS - Gas Chromatography/Mass Spectrometer
GC- Gas Chromatograph
ICP- Inductively Coupled Plasma

Appendix K

7. Sample Handling and Custody Requirements

A chain-of-custody (COC) program will be followed during sample handling activities from the field through laboratory operations. The COC program is designed to assure that each sample is accounted for at all times. Field data sheets, COC records, and sample labels will also be completed for each sample collected. In general, the objective of the COC identification and control system is to assure, to the extent practical, that all samples are uniquely identified, the correct samples are analyzed for the correct parameters, and samples are protected from loss or damage. COC procedures to be followed are included in Appendix S along with a sample COC form.

Appendix L

8. Analytical Precision and Accuracy:

Table 8 summarizes target compound lists for analytical methods, method detection limits, and precision / accuracy, as applicable. The method detection limits (MDLs) indicated in Table 8 are statistically calculated MDLs.

Table 8: Laboratory Analytical Precision and Accuracy

Analyte	Analytical Method	Method Detection soil-mg/kg, water-ug/l	Precision (%)	Accuracy (%)
Chloromethane	1a	0.02, 0.5		70-130
Bromomethane		0.04, 0.5		70-130
Dichlorodifluoromethane		0.04, 0.5		70-130
Vinyl Chloride		0.04, 0.5	<=30	70-130
Chloroethane		0.03, 0.5		70-130
Ethanol		0.75, 0.5		70-130
Iodomethane		0.02, 0.5		70-130
Methylene Chloride		0.02, 0.5		70-130
Acrolein		0.98, 0.5		70-130
Acetone		2.00, 0.5		70-130
Acrylonitrile		0.03, 0.5		70-130
Carbon Disulfide		0.02, 05		70-130
Trichlorofluoromethane		0.03, 0.5		70-130
1,1-Dichloroethylene		0.03, 0.5	<=30	70-130
1,1-Dichloroethane		0.02, 0.5		70-130
Trans 1,2-Dichloroethylene		0.04, 0.5		70-130
Chloroform		0.04, 0.5	<=30	70-130
2-Butanone (MEK)		0.16, 0.5		70-130
1,2-Dichloroethane		0.02, 0.5		70-130
Dibromomethane		0.02, 0.5		70-130
1,1,1-Trichloroethane		0.04, 0.5		70-130
Carbon Tetrachloride		0.04, 0.5		70-130
Vinyl Acetate		0.10, 0.5		70-130
Bromodichloromethane		0.01, 0.5		70-130
1,2-Dichloropropane		0.02, 0.5	<=30	70-130
cis 1,3-Dichloropropene		0.02, 0.5		70-130
Trichloroethylene		0.02, 0.5		70-130
Benzene		0.01, 0.2		70-130
Chlorodibromomethane		0.02, 0.5		70-130

* The quantitation limit is equal to 3.18 times the method detection limit

Table 8: Laboratory Analytical Precision and Accuracy (continued)

Analyte	Analytical Method	Method Detection soil-mg/kg, water-ug/l	Precision (%)	Accuracy (%)
Trans 1,3-Dichloropropene	1a	0.02, 0.5		70-130
1,1,2-Trichloroethane		0.02, 0.5		70-130
2-Chloroethylvinylether		0.01, 0.5		70-130
Bromoform		0.01, 0.5		70-130
4-Methyl-2-Pentanone		0.14, 0.5		70-130
2-Hexanone		0.12, 0.5		70-130
1,2,3-Trichloropropane		0.01, 0.5		70-130
Tetrachloroethylene		0.01, 0.5		70-130
1,1,2,2-Tetrachloroethane		0.01 0.5		70-130
Trans 1,4-Dichloro-2-Butene		0.01, 0.5		70-130
Ethyl Methacrylate		0.02, 0.5		70-130
Toluene		0.01,0.5	<=30	70-130
Chlorobenzene		0.01, 0.5		70-130
Ethylbenzene		0.01, 0.5	<=30	70-130
Styrene		0.02, 0.5		70-130
Xylene		0.02, 0.5		70-130
Cis 1,4-Dichloro-2-Butene		0.02, 0.5		70-130
Dichlorobenzenes		0.02, 0.5		70-130
MTBE		0.02, 0.5		70-130
			water (soil)	*water (soil)*
Silver	2a	0.50, 1	<=20 (35)	75-125 (70-140)
Arsenic		1.00, 5	<=20 (35)	75-125 (70-140)
Barium		0.50, 2	<=20 (35)	75-125 (70-140)
Cadmium		0.50, 0.25	<=20 (35)	75-125 (70-140)
Chromium		0.50, 2	<=20 (35)	75-125 (70-140)
Lead		0.50, 1	<=20 (35)	75-125 (70-140)
Selenium		1.00, 3	<=20 (35)	75-125 (70-140)
Mercury	*(6a)*	0.02, 0.2	<=20 (35)	75-125 (70-140)
Copper		0.8,4	<=20 (35)	75-125 (70-140)
Nickel		4,20	<=20 (35)	75-125 (70-140)
C9-C18 Aliphatic Hydrocarbons	3a	-	<=25	40-140
C19-C36 Aliphatic Hydrocarbons		-	<=25	40-140
C11-C22 Aromatic Hydrocarbons		-	<=25	40-140
Naphthalene		0.09,0.14	<=25	40-140
2-Methylnaphthalene		0.09,0.18	<=25	40-140
Acenaphythene		0.09,0.14	<=25	40-140
Acenaphthene		0.09,0.16	<=25	40-140
Fluorene		0.09,0.25	<=25	40-140
Phenanthrene		0.16,0.31	<=25	40-140
Anthracene		0.16,0.3	<=25	40-140
Fluoranthene		0.16,0.47	<=25	40-140
Pyrene		0.16,0.47	<=25	40-140

Benzo(a)fluoranthene		0.19,0.6	<=25	40-140
Benzo(k)fluoranthene		0.16,0.66	<=25	40-140
Benzo(a)pyrene		0.16,0.5	<=25	40-140
Indeno(1,2,3-cd)pyrene		0.13,0.41	<=25	40-140
Dibenzo(a,h)anthracene		0.13,0.44	<=25	40-140
Benzo(g,h,l)perylene		0.13,0.57	<=25	40-140

* The quantitation limit is equal to 3.18 times the method detection limit.

Table 8: Laboratory Analytical Precision and Accuracy (continued)

Analyte	Analytical Method	Method Detection soil-mg/kg, water-ug/l	Precision (%)	Accuracy (%)
Aroclor 1260	4a	0.03, 0.1	0-20	70-130
Aroclor 1254		0.03, 0.1	0-20	70-130
Aroclor 1248		0.03, 0.1	0-20	70-130
Aroclor 1242		0.03, 0.1	0-20	70-130
Aroclor 1232		0.03, 0.1	0-20	70-130
Aroclor 1221		0.03, 0.1	0-20	70-130
C5-C8 Aliphatic Hydrocarbons	5a	-	<=25	70-130
C9-C12 Aliphatic Hydrocarbons		-	<=25	70-130
C9-C10 Aromatic Hydrocarbons		-	<=25	70-130
Benzene		0.14,0.21	<=25	70-130
Toluene		0.42,0.55	<=25	70-130
Ethylbenzene		0.16,0.16	<=25	70-130
m/p-Xylenes		0.51,0.62	<=25	70-130
o-Xylene		0.28,0.81	<=25	70-130
Naphthalene		0.15,1.57	<=25	70-130
Methyl-tert-butylether		0.39,0.47	<=25	70-130

* The quantitation limit is equal to 3.18 times the method detection limit.

Appendix M

8. Field Quality Control Requirements

During all soil collection activities, various field quality control samples will accompany the soil samples to the laboratory. These quality control samples include duplicates, equipment blanks, VOA trip blanks, and cooler temperature blanks, as shown in Table 9.

Blank samples provide a measure of contamination that has been introduced into a sample either in the field or in the laboratory. To prevent the inclusion of non-site related contaminants into the data assessment, chemical concentrations detected in the blanks are compared to the field samples collected. Results of blank sample analyses may contain common laboratory contaminants such as acetone, 2-butanone, methylene chloride, toluene, and phthalate esters. These chemicals are considered by the EPA as common laboratory contaminants.

Any reported concentrations of analytes from the equipment blank or trip blank will be evaluated by the laboratory and VHB. Concentrations will be compared to results of other samples collected and transported along with these quality control samples. If warranted, re-sampling or re-analysis may be required.

The EPA has established guidelines to use when comparing blank results to field sample results. The guidelines are as follows:

- When the blank contains common laboratory contaminants, field sample results should be considered as positive results only if the chemical concentration in the field sample exceeds ten times the maximum amount detected in the blank.
- When the blank contains detectable levels of one or more chemicals that are not considered by the EPA as common laboratory contaminants, field sample results should be considered as positive results only if the chemical concentrations in the field sample exceeds five times the maximum amount detected on any blank.

The above approach is not generally recommended for screening out chemicals at smaller, non-superfund sites, due to the small sample size frequently encountered. The approach that may be used, based on a review of the actual results, is resampling to confirm the presence or absence of a contaminant. In addition, the Region I Guidelines for Data Validation may be used to develop action levels for common laboratory contaminants that may be detected in laboratory blanks.

Table 9: Field Quality Control Requirements

QC Sample	Frequency	Acceptance Criteria	Corrective Action
Duplicate	One/20 samples/matrix	=50% RPD	Review field notes and determine if reanalysis is required.
Equipment Blank	All sampling will be performed using dedicated disposable equipment, therefore equipment blank are not required.	---	---
VOA Trip Blank (groundwater)	One per cooler.	Less than the quantitation limit of field sample.	Results will be qualified or rejected.
Methanol Trip Blank (soil)	One per cooler.	Less than the quantitation limit of field sample.	Results will be qualified or rejected.
Cooler Temperature Blank	One per cooler.	0-4°C	Results will be qualified or rejected.
Bottle Blank	Bottles prewashed with certificate of analysis included, therefore bottle blank is not required.	---	---

Appendix M (Cont.)

8. Laboratory Quality Control Requirements

Along with the field quality control requirements, the Massachusetts DEP-certified laboratory being utilized for this project maintains a quality control / quality assurance program. Table 10 summarizes the laboratory quality control requirements.

Relative Percent Difference (RPD) is a measure of precision and the percent surrogate recovery is a measure of accuracy. The objective of the laboratory concerning precision is to equal or exceed the precision demonstrated in the published analytical method on similar samples. RPD is calculated as follows:

$$RPD = \frac{(\text{Sample Result - Duplicate Result})}{\text{Mean of Sample and Duplicate Results}} \times 100$$

The objective of the laboratory concerning accuracy is to equal or exceed the accuracy demonstrated in the published analytical method on similar samples. Accuracy is determined on matrix spikes and / or blank spikes and is calculated as follows:

$$\text{Percent Recovery} = \frac{(\text{Observed - Sample}) \text{ Concentration}}{\text{Spiked Concentration}} \times 100$$

Precision is a measure of the reproducibility of the results. This quality control indicator is evaluated by examining the variability of results from field duplicates and laboratory duplicates. The precision objective for this investigation is to meet or exceed the criteria that have been established for the referenced analytical methodology. Corrective action will be implemented by the laboratory as necessary to correct any substantial deviations.

Accuracy is a measure of the closeness of the analytical result to the true concentration. The percent recovery of spiked samples and performance evaluation standards reflect whether the analytical result has a high or low bias. The accuracy objective for this investigation is to meet or exceed the criteria that

have been established for the referenced analytical methodology. Corrective action will be implemented by the laboratory as necessary to correct any substantial deviations.

Table 10: Laboratory Quality Control Requirements

QC Sample	Frequency	Acceptance Criteria	Corrective Action
Extraction Blank	One/20 samples/matrix	Less than the reporting limits	Depending on concentration, results will be qualified or rejected.
Laboratory Fortified Blank (LFB)	One/20 samples/matrix	See Below*	Depending on concentration, results will be qualified or rejected.
Duplicate	One/20 samples/matrix	<50% RPD	VHB to discuss results with lab to determine if reanalysis/resampling is required.
Surrogates	All extracted standards and associated QC	See Below*	Laboratory to reanalyze sample**
Matrix Spike	One/20 samples/matrix	See Below*	Laboratory to reanalyze sample**
Laboratory Control Sample (LCS)	One/20 samples/matrix	See Below*	Laboratory to reanalyze sample**

Notes:
*

Surrogates	% Recovery
VOCs	
Toluene-d8	75-125
Bromofluorobenzene	75-125
1,2-Dichloroethane-d4	75-125
PCBs	
Tetrachloro-m-xylene	40-120
Decachlorobiphenyl	40-120
EPH	40-140
VPH	70-130

Matrix Spikes, LFB, & LCS	% Recovery
VOCs	
1,1-Dichloroethene	61-145
Trichloroethene	71-120
Chlorobenzene	75-130
Benzene	76-127
Toluene	76-125
PCBs	
Aroclor 1242/1016	40-140
Aroclor 1260	40-140
EPH	40-140
VPH	70-130
RCRA Metals	75-125

** In some cases, the surrogate recovery will fall out of the acceptable percent recovery range indicated. In this case the laboratory will usually reanalyze the sample. Interference from non-target analytes, dilutions, or soil characteristics may prevent the laboratory from achieving an acceptable percent recovery. In this case, the laboratory will make note of these anomalies and the sample will not be reanalyzed. Other QC data will be used to validate the field samples.

*** Performance Evaluation (PE) Samples: Approximately one PE sample will be submitted per 20 samples analyzed per matrix. PE samples are samples with known concentrations of contaminants. Following analysis of these samples, the reported results are forwarded to the EPA for review and the results of the review are incorporated into the data validation process. The procedures and requirements contained in the EPA Region I Performance Evaluation Program Guidance (July 1996) will be followed and referenced.

Appendix N

9. Data Management and Documentation:

Following the receipt of all laboratory analytical reports, the report will be reviewed to confirm that all relevant laboratory quality control / quality assurance documentation is included. The elements of the data package are in accordance with the Brownfields Program Quality Assurance Project Plan Guidance, dated September 1998, and consist of the following:

- Data results, including PE sample results;
- Method blank results;
- Surrogate recoveries and acceptance limits;
- Matrix spike / matrix spike duplicate results and acceptance limits;
- Spike / duplicate results and acceptable limits;
- Laboratory control sample results and acceptance limits;
- ICP serial dilution results;
- ICP interference check sample results; and
- Project narrative, which contains all observations and deviations.

All laboratory results will be delivered to VHB electronically and in hard-copy form. Following the receipt of all laboratory reports, VHB will tabulate the results in a spreadsheet format using the electronically-delivered data. The electronic deliverable prevents the introduction of errors during data tabulation. The results of all data produced by the laboratory are automatically transferred to an electronic file. No manual data entry of the results is required, therefore eliminating the introduction of errors. All raw data including chromatograms and copies of internal chains of custody will be maintained by the laboratory.

All field data will be recorded in the form of field notes to maintain a permanent record of all field activities. Information will include, date, weather, individuals on site, field screening results, sampling observations and techniques, and any additional relevant information. All field notes and photographs will be maintained and stored in dedicated project files.

Appendix O

10. Assessment and Response Actions:

Throughout the course of the project, VHB will implement the following procedures to detect and correct any problems that may occur:

- Project management meetings;
- Peer reviews of all reports, documents, and correspondence;
- Weekly project team meetings;
- Periodic field meetings during all site investigations; and
- Ongoing communication between VHB's project team, the City of Worcester, the EPA, and all Subcontractors.

As warranted, problems that occur will be communicated through the issuance of project memorandums and telephone conversations. All correspondence will detail the problem encountered and any corrective actions taken. All memorandums and telephone notes will be maintained in dedicated project files.

documented in the field notes.

Appendix P

11. Project Reports:

Following the completion of various tasks, formal and informal reports shall be prepared which include the following:

- Miscellaneous project memorandums and correspondence; and
- Phase I Initial Site Investigation Report
- Phase II Comprehensive Site Assessment Report.

Reports shall be submitted to the City of Worcester for draft review. Following all comments, the reports will be finalized and issued to the City of Worcester and the EPA. Project status memorandums shall be prepared on a bi-weekly basis throughout the course of the project.

Appendix Q

12. Data Validation :

a. Data Review Process

Following the receipt of a laboratory analytical report, all samples results and quality control information will be reviewed by an experienced environmental professional. Original chains of custody will be compared to the laboratory report to ensure that all samples provided to the laboratory were analyzed for the correct parameters using EPA-approved methodologies and that no holding times were exceeded. Criteria established in Table 3 will be used to perform data validation, which includes a review of maximum holding times, a review a preservation requirements, and a comparison of actual field procedures compared to established field standard operating procedures included in Appendix S. Data validation will also be performed by the laboratory analyst prior to reporting results to VHB, in accordance with their published QA protocols.

The laboratory will review data against pre-existing criteria before proceeding with subsequent analytical processes and/or data. The laboratory will be responsible for instituting any required corrective action. Criteria used for accepting or rejecting any data is based on laboratory quality control and specific EPA methodology standard operating procedures.

A Modified Tier II Validation will be performed for all data packages received, including PE sample results. Raw data and calibration data will not be included with the data package. The validation will be performed in accordance with Region I Tiered Organic and Inorganic Data Validations, dated July 1, 1993 and Region I EPA-NE Data Validation Functional Guidelines for Evaluating Environmental Analyses, dated July 1996.

Analyte concentrations will be compared to contaminant concentrations in equipment/rinsate blanks and method/reagent blanks to identify possible sources of false positives. Data quality will be validated by reviewing all quality control analyses. Any deviations that could not be rectified by the laboratory will be documented in the project narrative.

b. **Data Validation Tier** (circle one): Tier I Tier II Tier III

Is the circled Data Validation Tier applicable to all parameters / matrices analyzed during this project? (circle one)

Yes No

If no, document the Validation Tier per parameter / matrix in the table below.

Have the data validation procedures been modified? (circle one) Yes No

If yes, document modifications in the table below.

Modifications to Tier II Data Validation include: modified completeness check (raw data and calibration data will not be included in the data package). All results of the data validation will be summarized in the final subsurface investigation report. The report will be prepared to document all field activities, analytical results, and results of the data validation.

Appendix R

13. Data Usability:

Data usability will be based on meeting some or all, but not limited to the following criteria:

- Deviations from any standard operating procedures will be reviewed to identify potential limitations in the data. If a substantial deviation to standard operating procedure is identified, consideration may be given to either resampling or disregarding the sample result.
- The analytical methods chosen include method detection limits that are below applicable Massachusetts Contingency Plan (MCP) Reportable Concentrations (RCs). This approach ensures that all data received can be directly compared to applicable MCP RCs. If a detection limit is at or above the concentration of concern, the detection limit may be lowered and the sample may be reanalyzed if technically possible to do so.
- If concentrations of target analytes are at or near a RC, quality control data (blanks, spikes) will be scrutinized to determine the likelihood of false negatives and false positives. If QC data indicates that precision or accuracy is determined to be outside method specific criteria, then an evaluation of the data will be performed to determine where and how this QC issue affects the use of the data. The results of this evaluation will be presented in the final report along with a discussion of any limitations in the way the data should be used. If, after the evaluation, it is determined that the data is unusable, the data will be rejected and possible corrective actions will be documented in the final report.
- A review of sample representativeness from field notes will be performed. A non-representative or non-homogeneous sample increases the potential for false negatives or false positives. Adherence to applicable field sample collection protocols, field QC measures, and transport and storage of sample to the laboratory will decrease the possibility of having a sample result that is not representative of true site conditions.
- Poor data quality or lost samples will decrease confidence in the data set. To ensure completeness, adherence to all field protocols, sample tracking procedures, and laboratory procedures shall be maintained. Completeness will be described in terms of the total number of samples that meet data validation requirements compared to the total number of samples that do

not satisfy such requirements.

- assessment will be documented in the final report.

Data usability will be performed based on the Modified Tier II Validation, the above listed elements, actual field observations and conditions, and in accordance to EPA Region I - New England Data Validation Functional Guidelines for Evaluating Environmental Analyses, dated July 1996. All results of the data usability will be summarized in the final subsurface investigation report.

Appendix S
Field Standard Operating Procedures

Appendix T
Laboratory Standard Operating Procedures